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HEIGHT GROWTH IN WESTERN WHITE PINE PROGENIES

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ABSTRACT

Heights of 31 progenies of western white pines from four geographic localities and four crosses between localities were assessed on 14-year-old trees at two sites. Differences in height among individual progenies were detected but could not be related to localities or crosses between localities. Although differential effects of sites on tree height became apparent after age 9, differences among progenies were similar on both sites.

Assessment of genetic superiority and environmental adaptation in height growth of forest trees ultimately must be based on field tests over extended periods. Even though differences in height of 3- to 5-year-old progenies of western white pines (*Pinus monticola* Dougl.) varied in three natural environments (Squillace and Bingham 1958), the value of data involving juvenile performance depends on the correlation between performance at juvenile and mature ages. Whereas statistically significant correlations have been observed between height at age 5 and height at ages near 10 for *Pinus resinosa* Ait. (Lester and Barr 1966) and *P. ponderosa* Laws. (Callaham and Duffield 1962), the relative height of progenies of *P. ponderosa* (Callaham and Liddicoet 1961) and *Pseudotsuga menziesii* (Mirb.) Franco (Silen 1965) changed greatly after age 20. The present paper concerns variation in height of western white pine progenies up to 14 years of age.

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MATERIALS AND METHODS

Data were taken from 31 progenies that had been field-planted in 1957 as 3-year-old seedlings. Field tests were established in northern Idaho on two sites: (1) a north aspect at an elevation of 3,650 feet on the Deception Creek Experimental Forest, Kootenai County; and (2) a northwest aspect at an elevation of 2,500 feet on the Priest River Experimental Forest, Bonner County.

The progenies represented four geographic locations in northern Idaho and four crosses between localities. Geographic localities included: (1) Crystal Creek, Benewah County, 2,850 feet elevation; (2) White Rock, Shoshone County, 5,000 feet elevation; (3) Gold Center, Shoshone County, 2,950 feet elevation; and (4) Elk Creek, Clearwater County, 3,000 feet elevation (figure 1, Squillace and Bingham 1958). Crosses between localities included Crystal Creek X White Rock, Gold Center, and Elk Creek; and White Rock X Elk Creek. A varying number of progenies were represented within localities and crosses between localities (table 1).

Table 1.--*Mean height of 14-year-old trees from individual progenies representative of interlocality or intralocality crosses*

Origin of progenies									
Intralocality crosses			A[1]	B[2]	Interlocality crosses			A[1]	B[2]
			--*Feet*---					---*Feet*---	
Maternal tree no.		Paternal tree no.			Maternal tree no.		Paternal tree no.		
Crystal Creek			7.09		Crystal Creek X White Rock			5.91	
15	X	wind[3]		6.23	54	X	19		5.73
15	X	20		6.67	63	X	20		6.31
18	X	wind		7.56	69	X	19		6.36
19	X	wind		7.32	69	X	20		6.05
20	X	wind		6.71	70	X	19		5.15
20	X	21		7.59	70	X	20		5.83
21	X	wind		7.79					
21	X	27		6.70	Gold Center X Crystal Creek			6.91	
25	X	wind		7.07					
25	X	18		6.82	23	X	20		6.91
58	X	wind		7.57					
					Elk Creek X Crystal Creek			6.93	
White Rock			5.97						
					62	X	19		6.51
54	X	wind		5.45	62	X	25		6.15
63	X	wind		5.99	62	X	58		7.94
69	X	wind		6.69	18	X	64		7.09
70	X	wind		5.75	19	X	59		6.97
Elk Creek			7.36		White Rock X Elk Creek			6.67	
59	X	wind		7.54	69	X	59		6.67
59	X	64		7.17					
Gold Center			6.57						
23	X	wind		6.57					

[1]Group means. [2]Progeny means. [3]Pollen carried by wind; paternal parentage unknown.

Height of all trees was measured at ages 4, 9, and 14. The following is the analysis of variance applied to the data:

Source of variation	*Symbol*	*Mean square code*	*Unweighted components expected in each mean square*	*Coded tester*
Sites	S	6	$\sigma^2_E + \sigma^2_{PB/S} + \sigma^2_{PS} + \sigma^2_{B/S} + \sigma^2_S$	5+3-2
Blocks within sites	B/S	5	$\sigma^2_E + \sigma^2_{PB/S} + \sigma^2_{B/S}$	2
Progenies	P	4	$\sigma^2_E + \sigma^2_{PB/S} + \sigma^2_{PS} + \sigma^2_P$	3
P X S	PS	3	$\sigma^2_E + \sigma^2_{PB/S} + \sigma^2_{PS}$	2
P X B/S	PB/S	2	$\sigma^2_E + \sigma^2_{PB/S}$	1
Within cells	E	1	σ^2_E	

RESULTS AND DISCUSSION

Analyses of variance for height at ages 9 and 14 and the analysis of covariance of height at age 14 on height at age 9 (table 2) indicate that the effects of sites on tree height became apparent after age 9; 14-year-old trees growing on the Priest River site averaged 1.5 feet taller than those growing at Deception Creek, but at age 9 essentially no differences separated trees growing on the two sites. By contrast, differences in height among progenies and the effects of blocks within sites on tree height were expressed before age 9 and remained relatively constant up to age 14. The meaning of interactions involving progenies is obscure, for significant effects indicated by one analysis of variance were not verified by the second, and the analysis of covariance indicated nonsignificant changes in the effects of these sources of variation over the 5-year interval. It is probable that these interactions are of negligible importance in this test.

Table 2.--*Results of analyses of variance of 9- and 14-year heights and the analysis of covariance of 14-year height on 9-year height*

Source of variation	Degrees of freedom	Mean square ratios: Analysis of variance, 9-year height	Mean square ratios: Analysis of variance, 14-year height	Mean square ratios: Analysis of covariance
Sites	1	0.18	[1]9.72*	275.61**
Blocks within sites	4	8.89**	6.44**	.96
Progenies	30	1.68*	2.09*	1.13
P X S	30	1.56*	1.11	1.39
P X B/S	120	.99	1.33*	1.09
Within cells	[2]554			

[1]Single (*) and double (**) asterisks, respectively, indicate significance at the 5- and 1-percent levels of probability.

[2]Degrees of freedom reduced by 1 for the statistically significant regression (1-percent level of probability) in the analysis of covariance.

Although mean height of trees representative of different localities or crosses between localities differed by as much as 1.4 feet (table 1), Scheffé's "S" test for multiple mean comparisons (Scheffé 1958) indicated that differences detected among progenies (table 2) were not related (5-percent level of probability) to either the elevation or locality of progeny origin. By contrast, western white pine seedlings from localities of low and high elevations differed in height particularly in a high-elevation environment (about 4,400 feet) (Squillace and Bingham 1958). The divergent results of the present study may reflect an absence of a test site at a high elevation, for many of the same progenies were represented in both studies.

Despite a large variation in mean performance of individual progenies (table 1), differences were detected at only the 5-percent level of probability (table 2). Performance of individual trees within progenies was thus highly variable; that this variation results primarily from large genetic heterogeneity of parental trees is consistent with conclusions of Hanover and Barnes (1969).

The consistency in mean growth of progenies between ages 9 and 14 is further elucidated by correlation coefficients among mean height of progenies for ages 4, 9, and 14:

Tree ages (Years)	*Correlation coefficient (r)*
4 and 9	0.68
4 and 14	.61
9 and 14	.92

All coefficients are statistically significant at the 1-percent level of probability and suggest that observed differences in the height of progenies at age 14 were apparent not only at age 9 but probably at age 4, one year after the plantings were established. The possibility exists, however, that changes in height such as observed in *Pinus ponderosa* (Callaham and Liddicoet 1961) and *Pseudotsuga menziesii* (Silen 1965) may become apparent in later years.

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